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Three-dimensional fractal models of electrochemical processes

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Abstract

Self-similar electric circuits that represent three-dimensional models of different physical processes (phenomena of dielectric relaxation, electrochemical processes, etc.) are considered. For the first time, exact functional equations for the overall conductance (admittance) Y(jω) of these resistance-capacitance circuits are derived and solved. Based on the self-similar structure of circuits, it is shown that in the frequency range, admittance represents a sum of fractional-exponential expressions with one real and a pair of complex-conjugate exponents (in further text, complex exponents). Thus, it is demonstrated that the set of processes occurring in different parts of the circuit and associated with charge transfer (capacitance C) and elementary resistance (Ohmic resistance R) is reduced to a fractional- exponential dependence of the (jωτ)ν form. It is shown that the exponent values are related only with the parameters that determine the self-similar structure of a circuit being independent (for a large number of circuit elements) of the particular form of the elementary circuit. These exponents are also successfully related to the dynamic fractal dimension (see Eq. (2.30)), which imparts them new geometrical meaning.

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Keywords

Fractals, Models of electrochemical processes, Self-similar electric circuits